

4 PRIORITY HAZARDS

To ensure the most effective use of their resources, the municipalities of Benton County have focused their initial hazard characterization and vulnerability analyses – and the resultant development of mitigation strategies – on three natural hazards: floods; windstorms; and wildfire. These three hazards are relatively frequent occurrences in Benton County, and can result in repetitive and often severe social, economic and physical damage.

4.1 Floods

4.1.1 Nature of the Flood Hazard

Flooding typically occurs when climate (or weather patterns), geology, and hydrology combine to create conditions where water flows outside of its usual channel onto surrounding lands. In Benton County, geography and climate combine to create chronic seasonal flooding conditions, typically in the winter and spring. Flooding can also occur from failure of dams and irrigation canals. Flooding in Benton County typically occurs along the Yakima River. Although flooding has occurred in the past along the Columbia River, levees and a system of dams now protect most of the developed areas along the Columbia River in Benton County. Flash flooding also occasionally occurs in canyons and gullies.

Winter floods are historically the largest in magnitude, although their duration is typically less than one week. The total volume of runoff from winter floods is less than those of spring floods. Spring flooding is usually caused by snowmelt during periods of warm weather and/or rain. Although the magnitude of spring floods is usually less than winter floods, the spring floods can last up to four weeks. The total volumes of runoff experienced during spring floods can be large.

Historical Flood Events

Yakima River Floods - In recent history, the most damaging floods in Benton County have been associated with the Yakima River. Benton County is the downstream end-point for the Yakima River drainage, which contains 6,155 sq. miles, or four million acres. The areas along the lower Yakima in Benton County especially vulnerable to relatively frequent flooding extend from Benton City downstream through West Richland to the delta where the Yakima empties into the Columbia River. This area is characterized by low lying river bottom lands and ancient river channels which are historically the river's natural floodway and floodplain (Benton County Comprehensive Plan). Since 1970, Benton County has been included within the area of five nationally declared flood disasters, all associated with the Yakima River. Table 4.1-1 lists the largest Yakima River Floods at Kiona (adjacent to Benton City).

Table 4.1-1 Largest Yakima River Floods at Kiona (draft CFHMP 2001)				
Date	Measurement at Kiona		Return Period^b (years)	Comments
	Flow (cfs)	Stage ^a (feet)		
December 23, 1933	67,000	21.57	167	Largest flood of record.
November 17, 1906	66,000	20.12	159	
December 1917 ^c	53,800 at Prosser	18.5 est.		
February 11, 1996	49,400	20.98	67	Benton County declared a federal disaster area
January 18, 1974	39,700	18.65	36	Benton County declared a federal disaster area.
November 18, 1896	38,000	16.07	34	
May 30, 1948	37,900	17.2	33	
December 13, 1921 ^c	35,800 at Parker			
April 17, 1904	32,000	15.05	18	
November 26, 1909	30,600	14.8	16	
March 23, 1910	29,200	14.53	14	
December 6, 1975	28,300	16.52	13	
December 28, 1980	27,600	16.27	12	
December 4, 1977	27,000	16.11	11	Benton County declared a federal disaster area.
March 3, 1901	26,400	14	10	
June 14, 1903	26,400	14	10	
December 2, 1995	26,300	15.87	9	Benton County declared a federal disaster area.
June 16, 1916 ^c	24,800 at Parker			
February 17, 1898	23,100	13.27	7	
November 27, 1990	22,600	14.36	7	Benton County declared a federal disaster area.
February 1, 1965	23,400	13.76	6	
February 22, 1982	22,200	14.42	6	
June 5, 1913	20,900	13.1	5	
February 13, 1951	20,900	13.99	5	
January 23, 1919 ^c	20,600 at Parker			
March 15, 1972	20,200	13.57	5	
May 22, 1956	20,100	12.73	5	

- Flood stage equals 13 feet for the period 1933 to present. It appears that the gage/flow relationship was different for the records between 1878 and 1914.
- Based on flood frequency curve for the Yakima River at Kiona over a 64 year period (1933-1997).
- Kiona flow gage was not operational during the period 1915 to 1932.

Representative Yakima River flood events are described below (excerpted from the 2001 draft Benton County Comprehensive Flood Hazard Management Plan (CFHMP)¹). Additional detail is available in the draft CFHMP.

February 11, 1996 Flood – The Feb. 11, 1996, flood is the fourth largest flood on record, with a recurrence interval of 67 years. This was a winter flood caused by warm weather and rainfall on top of a significant snowpack. The flood affected most of the Yakima River basin. In Benton County, Benton City, West Richland, and Richland were affected the most. Parts of Benton City were evacuated. In West Richland, two of three routes leading to Hanford and the Tri-Cities were cut off (the east approach to the Van Giesen Street Bridge and the south span of the Old Twin Bridges were inundated). Total damages were estimated at \$11, 363,448 (damages from the City of West Richland not included.)

December 2, 1995 Flood – This flood was a winter flood caused by unusually warm temperatures and rainfall. Benton City, West Richland, and Richland received the brunt of the flood impacts in Benton County. Trailers were moved to higher ground from the Beach Trailer Park in Benton City. West Richland evacuated residents in the Twin Bridges area and from a neighborhood northwest of the golf course, which flooded. Lowland areas surrounding Richland reported severe damage, with several houses surrounded by water. Several roads were closed, and both the Twin Bridges and Pederson Road outside of West Richland sustained damage.

November 27, 1990 Flood – This was a relatively minor winter flood also caused by high temperatures and rainfall occurring upstream. Losses were fairly minor, although approximately 40 residents within the floodplain around Benton City and West Richland were evacuated.

January 18, 1974 Flood – The January 1974 flood is the fifth largest flood on record, caused by a combination of warm weather, rainfall, and ice jams. Flood damage was extensive, and affected Prosser, Benton City, West Richland, and Richland. It was reported that 145 homes countywide had standing water at depths of 2 to 10 feet. A County Commissioner estimated total damages to roads and bridges as exceeding \$175,000. Many roads were closed, including SR 22 and SR 221 between Patterson and Prosser, SR 224 from Kiona to the SR 240 junction in Richland, Horn Road between Benton City and Hanford, SR 24, and others.

December 23, 1933 Flood – The December 23, 1933, flood is the largest Yakima River flood on record. Although a winter flood caused by warm weather and heavy rains, the flood was of unusually long duration. The Yakima River had a rate of rise of six feet per day, and remained out of bank for a total of 12 days. Low-lying areas around Benton City were the hardest hit, with the river near SR 224 reportedly one to two miles wide. Residents were evacuated by boat. Richland was cut off by the flood except for long-distance detours, as the flood closed the SR 224 bridge and the Twin Bridges (then known as Grosscup Road). Newspaper accounts report damage to dikes, irrigation structure, highways, and loss of numerous livestock and outbuildings. The County Commissioners estimated damage to county roads at \$6,300 (1933 dollars). The damage estimate did not include replacement

¹ Benton County Comprehensive Flood Hazard Management Plan (CFHMP), March 2001. Prepared for Benton County by Tetra Tech/KCM Inc. Note – the CFHMP has not been adopted by Benton County, and therefore is referred to herein as the draft CFHMP. The draft CFHMP provides an excellent source of information on Benton County flood issues, however, it does not represent County policy.

costs for the Twin Bridges, which was washed out entirely. As a result of this flood, an extensive system of levees and flood control structures was implemented in Yakima County by the federal government, greatly reducing the threat of future floods of such magnitude for Benton County.

Columbia River Floods. Flooding has occurred in the past along the Columbia River. A flood in May 1948 inundated much of Kennewick as well as transportation routes along the river. Property damage in Benton and Franklin counties totaled \$702,000 – a significant amount for the time. Much of Richland and Kennewick are now protected by levees along the Columbia River. In addition, McNary Dam, and other dams throughout the Columbia Basin, provide a measure of flood control for Benton County communities along the Columbia River.

Other County Floods. In January 1997, several small streams tributary to the Columbia River in the southern half of Benton County flooded. The flooding was caused by heavy rainfall in the lowlands that melted accumulated snow. County roads were washed out, reportedly due to inadequate sizing of roadside ditches and culverts, as well as debris and sediment blocking many structures. Total damage was estimated at \$359,660 (draft CFHMP).

Flood Characteristics

Two types of flooding primarily affect Benton County: riverine flooding and urban flooding (see descriptions below). In addition, any low-lying area has the potential to flood. The flooding of developed areas may occur when the amount of water generated from rainfall and runoff exceeds a storm water system's (ditch or sewer) capability to remove it.

Riverine Flooding

Riverine flooding is over-the-bank flooding of rivers and streams. The natural processes of riverine flooding add sediment and nutrients to fertile floodplain areas. Flooding in large river systems typically results from large-scale weather systems that generate prolonged rainfall over a wide geographic area, causing flooding in hundreds of smaller streams, which then drain into the major rivers. Shallow area flooding is a special type of riverine flooding. FEMA defines shallow flood hazards as areas that are inundated by the 100-year flood with flood depths of only one to three feet. These areas are generally flooded by low-velocity sheet flows of water.

Urban Flooding

As land is converted from fields or woodlands to roads and parking lots, it loses its ability to absorb rainfall. Urbanization of a watershed changes the hydrologic systems of the basin. Heavy rainfall collects and flows faster on impervious concrete and asphalt surfaces. The water moves from the clouds to the ground, and into streams at a much faster rate in urban areas. Adding these elements to the hydrological systems can result in floodwaters that rise very rapidly and peak with violent force. Benton County's incorporated towns and cities have a relatively high concentration of impermeable surfaces that either collect water, or concentrate the flow of water in man-made channels. During periods of urban flooding, streets can become swift moving rivers and basements can fill with water. Storm drains often back up with vegetative debris causing additional, localized flooding.

Floodplain

A floodplain is a land area adjacent to a river, stream, lake, estuary, or other water body that is subject to flooding. This area, if left undisturbed, acts to store excess floodwater. The floodplain is made up of two sections: the floodway and the flood fringe.

Floodway

The floodway is one of two main sections that make up the floodplain. Floodways are defined for regulatory purposes. Unlike floodplains, floodways do not reflect a recognizable geologic feature. For NFIP purposes, floodways are defined as the channel of a river or stream, and the overbank areas adjacent to the channel. The floodway carries the bulk of the floodwater downstream and is usually the area where water velocities and forces are the greatest. NFIP regulations require that the floodway be kept open and free from development or other structures that would obstruct or divert flood flows onto other properties. The NFIP floodway definition is “the channel of a river or other watercourse and adjacent land areas that must be reserved in order to discharge the base flood without cumulatively increasing the water surface elevation more than one foot.” Floodways are not mapped for all rivers and streams but are generally mapped in developed areas.

Flood Fringe

The flood fringe refers to the outer portions of the floodplain, beginning at the edge of the floodway and continuing outward. This is the area where development is most likely to occur, and where precautions to protect life and property need to be taken.

Development

For floodplain ordinance purposes, development is broadly defined to mean “any manmade change to improved or unimproved real estate, including but not limited to buildings or other structures, mining, dredging, filling, grading, paving, excavation, or drilling operations located within the area of special flood hazard.” The definition of development for floodplain purposes is generally broader and includes more activities than the definition of development used in other sections of local land use ordinances.

100-Year Flood

The 100-year flooding event is the flood having a one percent chance of being equaled or exceeded in magnitude in any given year. Contrary to popular belief, it is not a flood occurring once every 100 years. The 100-year floodplain is the area adjoining a river, stream, or watercourse covered by water in the event of a 100-year flood.

Base Flood Elevation (BFE)

The term “Base Flood Elevation” refers to the elevation (normally measured in feet above sea level) that the base flood is expected to reach. Base flood elevations can be set at levels other than the 100-year flood. Some communities choose to use higher frequency flood events as their base flood elevation for certain activities, while using lower frequency events for others. For example, for the purpose of storm water management, a 25-year flood event might serve as the base flood elevation, while the 500-year flood event may serve as base flood elevation for the tie down of mobile homes. The regulations of the NFIP focus on development in the 100-year floodplain.

Dam Failure Flooding

Loss of life and damage to structures, roads, utilities and crops may result from a dam failure. Economic losses can also result from a lowered tax base and lack of utility profits. These effects would certainly accompany the failure of one of the major dams affecting the Columbia, Snake, or Yakima rivers. Because dam failure can have severe consequences, FEMA requires that all dam owners develop Emergency Action Plans (EAP) for warning, evacuation, and post-flood actions. Although there may be coordination with municipal officials in the development of the EAP, the responsibility for developing potential flood inundation maps and facilitation of emergency response is the responsibility of the dam owner.

Effect of Development on Floods

When structures or fill are placed in the floodway or floodplain, water is displaced. Development raises the river levels by forcing the river to compensate for the space obstructed by the inserted structures and/or fill. When structures or materials are added to the floodway or floodplain and no fill is removed to compensate, serious problems can arise. Floodwaters may be forced away from historic floodplain areas. As a result, other existing floodplain areas may experience floodwaters that rise above historic levels.

Local governments must require engineer certification to ensure that proposed developments will not adversely affect the flood carrying capacity of the Special Flood Hazard Area (SFHA). Displacement of only a few inches of water can mean the difference between no structural damage occurring in a given flood event, and the inundation of many homes, businesses, and other facilities. Careful attention should be given to development that occurs within the floodway to ensure that structures are prepared to withstand base flood events. In highly urbanized areas, increased paving can lead to an increase in volume and velocity of runoff after a rainfall event, exacerbating the potential flood hazards. Care should be taken in the development and implementation of storm water management systems to ensure that these runoff waters are dealt with effectively.

Sediment Transport and Deposition

Sediment deposited in the river channel can promote channel migration and reduce the channel's conveyance capacity for high flows. Large quantities of sediment can be moved over short periods during flood events. Sediment deposition occurs where the river becomes flatter or wider, reducing the energy of its flow and thus its sediment transport capacity, its ability to carry sediment downstream. Sediment transport increases and deposition decreases near channel constrictions or areas where flow velocity increases (draft CFHMP 2001).

Effects of Levees

Levees attempt to keep floodwaters within a designated channel by confining them instead of allowing them to spill over into the floodplain. Levees provide a certain level of protection to floodplain residents; however, they can raise floodwater elevations upstream by creating a backwater effect, increase flow velocities, reduce side channel fish habitat, increase channel migration, and negate the affects of floodplain storage, leading to greater flood magnitudes downstream.

All levees and berms provide some level of flood protection. Many only protect during low-level, high-frequency floods, such as 1 to 10 year events. Small levees typically fail during significant flood events. In spite of their shortcomings during major floods, many farmers and businesses construct levees to prevent small frequent floods from causing damage by killing crops, eroding banks, and depositing unwanted silt (draft CFHMP 2001).

Identification of Flood-Prone Areas

Flood maps and Flood Insurance Studies (FIS) are often used to identify flood-prone areas. The NFIP was established in 1968 as a means of providing low-cost flood insurance to the nation's flood-prone communities. The NFIP also reduces flood losses through regulations that focus on building codes and "sound floodplain management". NFIP regulations (44 Code of Federal Regulations [CFR] Chapter 1, Section 60.3) require that all new construction in floodplains must be elevated at or above base flood level. The Washington Building Code requires new construction to be elevated to one foot above the base flood elevation. Communities participating

in the NFIP may adopt regulations that are more stringent than those contained in 44 CFR 60.3, but not less stringent

Flood Insurance Rate Maps (FIRM) and Flood Insurance Studies (FIS)

Floodplain maps are the basis for implementing floodplain regulations and for delineating flood insurance purchase requirements. A Flood Insurance Rate Map (FIRM) is the official map produced by FEMA, which delineates SFHA in communities where NFIP regulations apply. FIRMs are also used by insurance agents and mortgage lenders to determine if flood insurance is required and what insurance rates should apply.

Water surface elevations are combined with topographic data to develop FIRMs. FIRMs illustrate areas that would be inundated during a 100- year flood, floodway areas, and elevations marking the 100-year-flood level. In some cases they also include base flood elevations (BFEs) and areas located within the 500-year floodplain.

Flood Insurance Studies and FIRMs produced for the NFIP provide assessments of the probability of flooding at a given location. FEMA conducted many Flood Insurance Studies in the late 1970s and early 1980s. These studies and maps represent flood risk at the point in time when FEMA completed the studies. However, it is important to note that not all 100-year or 500-year floodplains have been mapped by FEMA

FEMA flood maps are not entirely accurate. These studies and maps represent flood risk at the point in time when FEMA completed the studies, and does not incorporate planning for floodplain changes due to new development since the studies were completed. Although FEMA is considering changing that policy, it is optional for local communities. Since the FEMA flood maps were completed for Benton County, man-made and natural changes to the environment have changed the course of many of the rivers and watercourses, as well as their associated floodplain boundaries.

4.1.2 Flood Hazard Assessment

Likelihood of Occurrence

Natural Flood Hazard

The draft CFHMP describes hydrologic/hydraulic investigations that have been conducted in Benton County over the last 40 years, including FEMA Flood Insurance Rate Studies for Benton County (1982, revised 1990 and 1994), Benton City (1979), Kennewick (1979), Prosser (1976), Richland (1979), and West Richland (1981). These and other studies provide extensive floodplain mapping, particularly of the Yakima River. However, the draft CFHMP notes that flood elevations and floodplain boundaries have long been disputed within the Yakima River area.

Based on a review of historical flood accounts and available information, the draft CFHMP concluded:

- 1) Major flood damage is typically caused by high-magnitude winter floods. Eighteen of the 24 largest Yakima River floods were winter floods.

- 2) Flood related damages have been concentrated in the low-lying areas between Benton City and the Richland-West Richland area.
- 3) Flooding problems in the Horse Heaven Hills are relatively infrequent, but can cause significant wide spread damage to county roads when flash floods occur.
- 4) Flood problems that have occurred repeatedly include the following:
 - Inundation of property and homes along Byron Road near the river west of Prosser and excessive erosion of the road.
 - Inundation of property and roads south of Babs Avenue in Benton City and low-lying areas north (downstream) of town.
 - Inundation of roads, homes and property, farmland and grazing pastures in the Richland-West Richland area, extending from the Twin Bridges south to Sunset Memorial Gardens and W. E. Johnson Park.

Due to the dams and dikes along most of the Columbia River in Benton County, naturally occurring flooding problems on the Columbia River are not likely. Water levels in the Columbia River are largely controlled by the McNary Dam; the Columbia River through most of Benton County is essentially a lake. On the Hanford Site, the Columbia River is not controlled. There, the probable maximum flood could cause some flooding and problems, but would have little effect on the rest of the County.

Based on the above information, the likelihood of occurrence of a major flood hazard on the Yakima River within the five-year planning cycle is **high**. The likelihood of occurrence of a major flood hazard on the Columbia River within the five-year planning cycle is **low**, with the exception of the Columbia Park area in Kennewick, which has a **medium** likelihood of occurrence of a flood hazard.

Dam Failure Hazard

Dam failure is an identified hazard in the Benton County Comprehensive Emergency Management Plan. According to Appendix 7 of the Comprehensive Emergency Management Plan, there are 11 dams in Benton County, including three of sufficient size to warrant inspection under the National Dam Inspection Act (PL 92-367). Blair Dam, located south of Kennewick, was inspected and found to be unsafe with a high downstream hazard potential.

There are seven dams upstream of Benton County on the Columbia River. Failure of these dams could inundate a large part of the county, including significant portions of Richland, West Richland, and Kennewick.

There are also several dams along the Yakima River. Failure of the Tieton or Cle Elum dams would likely inundate portions of Prosser, Benton City, West Richland, and Richland. Failure of the Kacess, Keechelus, Eastern Diversion or Bumping Lake dams would likely increase water levels within the Yakima River floodplain.

Failure of Ice Harbor Dam or any of the dams above it on the Snake River could flood parts of Finley and Kennewick along the Columbia River, and some parts of Richland along the Yakima River. The Lower Snake River Project features four locks and dams in the state of Washington: Ice Harbor Dam, Lower Monumental Dam, Little Goose Dam, and Lower Granite Dam. These four dams are all run-of-river facilities, and pass water through the dam at about the same rate as it enters the reservoir. These dams have limited storage capacity and were not built to control floods.

A breach of an irrigation canal could cause localized flooding anywhere on the irrigation canal system. The network of irrigation canals throughout the County and the municipalities is extensive.

The likelihood of occurrence of a dam or irrigation canal failure creating a major flood hazard within the five-year planning cycle is **low**.

Exposure Assessment

Natural Flood Hazard

Exposure assessment is the second step of hazard assessment. It combines the floodplain boundary, generated through hazard identification, with an evaluation of the exposure to flooding of the population, property, infrastructure, and environment within the floodplain. The draft CFHMP (2001) analyzed historic records, FEMA flood maps, aerial photographs, and other information to identify the following primary areas exposed to flooding in Benton County (see also Figure 4.1-1 at the rear of this Chapter):

- 1) Local, state, and county roads in the West Richland/Richland area.
 - a. Benton County roads include Grosscup Road, North 46th Avenue, Pedersen Road, Ranch Road, Riverview Road, Snively Road, and Weidle Road.
 - b. City of Richland roads include Kingston Road, Gomer Road, Hyde Road, Jones Road, and Buckskin Loop.
 - c. State roads include SR 224/Van Giesen Street.
- 2) Local, state, and county roads in the Benton City and Prosser area.
 - a. Benton County roads include Hamilton, Massingale, Pendleton, and Tilstra roads located north of Benton City on the west bank of the Yakima River; and Byron Road, located west of Prosser on the south bank of the Yakima River.
 - b. Benton City roads include Babs Avenue, 7th Street, 1st Avenue, 2nd Street, Carol Avenue, Alma Avenue, and Abby Avenue.
 - c. State roads include SR 225 approaching the bridge from the north.
- 3) County roads in the Horse Heaven Hills Region, particularly secondary and unpaved roads.
- 4) Existing structures in the 100-year floodplain in the West Richland/Richland area
 - a. ~85 structures in the areas near Twin Bridges and Snively Roads (unincorporated Benton County).
 - b. ~33 structures along Ranch Road, Pederson Road, and North 46th Avenue (Richland).
 - c. ~52 structures in the floodplain north and south of Van Giesen Street (Richland).
- 5) Existing structures in the floodplain in the Benton City area.
 - a. ~ 150 structures in southeast Benton City
 - b. ~140 structures north of Benton City and east of River Road (unincorporated Benton County).
 - c. ~20 structures in a lowland area on the north bank of the river a mile upstream of the City limits (unincorporated Benton County).

- 6) Existing structures in the floodplain in the Prosser area.
 - a. ~50 structures on both sides of the river between Prosser and the Yakima County line (unincorporated Benton County).
- 7) Drainage ditches in the Benton City area.
- 8) Channel migration and low clearance under the Van Giesen Street Bridge.

Vulnerability (Risk) Analysis

A qualitative risk analysis was conducted based on local knowledge of past flood events, the likelihood of future flooding, and the types, quantity, and relative value of development (and potential damage) within the floodplain. The determination of flood hazard risk varied by community. Most of the residential developments subject to flooding are located outside city boundaries in the unincorporated areas of the County. Older homes in the Yakima River floodplain, constructed prior to their community's participation in NFIP, typically lack flood proofing and have a higher risk of incurring flood damage. The determination of risk levels (high, medium, or low) are shown below.

- ***High Risk of Incurring Flood Damage from Yakima River Floods***
 - Local, state, and county roads in the West Richland/Richland area.
 - Local, state, and county roads in the Benton City and Prosser area.
 - Existing structures in the 100-year floodplain in the West Richland/Richland area
 - Existing structures in the floodplain in the Benton City area.
 - Existing structures in the floodplain in the Prosser area.
- ***Medium Risk of Incurring Flood Damage from Yakima River Floods***
 - Drainage ditches in the Benton City area.
 - Channel migration and low clearance under the Van Giesen Street Bridge.
 - Columbia Park riverbank and Trailway in Kennewick.
- ***Medium Risk of Incurring Flood Damage from Local Floods***
 - County roads in the Horse Heaven Hills Region, particularly secondary and unpaved roads.
- ***Low Risk of Incurring Flood Damage from Columbia River Floods***
 - Columbia River flood plain.

Kadlec Medical Center conducted a self-analysis of its vulnerability to various hazards and other threats to the safety of its patients and staff and the continued operation of the hospital. It identified an emergency evacuation of the hospital in the event of a dam failure to be of low probability, but as creating major disruption of the hospital's operation and posing a severe threat to the safety of its patients. Kadlec Medical Center concluded that it was not fully prepared for a complete evacuation of the hospital. Evacuation procedures, mobile equipment, transport, and shelter for ambulatory patients were identified as areas where improvements in preparation and response were necessary.

4.1.3 Community Issues

Current Conditions

At present, there are limited flood control protection devices in operation or planned in the lower Yakima River. Levees exist on both banks of the Yakima River at its mouth. Additionally, a levee has been constructed on the south bank from the Van Giesen Street Bridge downstream for approximately one mile. The likely trend is for the frequency and magnitude of floods within the lower reaches of the Yakima River to increase as the upper water shed continues to urbanize and its natural storage capacity is diminished. Flooding in the Yakima River valley could cause property and infrastructure damage, evacuation of residents, and contamination of wells.

Kadlec Medical Center has identified a complete emergency evacuation of its patients as an area where there is currently insufficient preparation in place. Such an evacuation could become necessary in the event of a major dam failure upriver. A similar situation likely exists at other hospitals, medical centers, nursing homes, hospices, assisted care facilities, out-patient surgeries, and similar facilities in the County. Although the results of such a catastrophic dam failure would be devastating, the likelihood of such an event is considered small (e.g., the risk is low).

Flooding of the Columbia River, although considered of low likelihood of occurrence, could inundate some transportation routes (road and railroad) and low-lying areas of Finley.

In addition, the draft CFHMP identified several countywide flood issues of concern, including:

- 1) *Flood Warning and Emergency Response*, including
 - a. Delayed response by residents to flood warning and evacuation notices.
 - b. A general lack of public awareness of flood hazards.
 - c. A need for improved flood warning for floodplain residents.
 - d. A need for better correlation of stage, flow, and time delay of crest between Kiona gage and Richland area.
- 2) *Flood Insurance and Public Education*. The lack of public knowledge about flood hazards may result in limiting property owner involvement in the flood insurance program or taking steps to mitigate the flood hazard. The County is not a participant in FEMA's Community Rating System (CRS).
- 3) *Public Disclosure of Floodplain Status*. Property buyers are often unaware of the floodplain status of land being purchased.
- 4) *FEMA Flood Insurance Rate Maps*. The maps are a primary tool in identifying and responding to flood hazards; however, the current FIRM maps are based on hydrologic/hydraulic analyses done in 1979. The conditions supporting those 1979 analyses have likely changed.
- 5) *Funding for Flood Control Work and Restoration Projects*. The County does not have a secure source of funding for flood hazard management.
- 6) *Debris Maintenance*. Accumulated debris at bridge crossings, diversion structures, islands, drainage ditches, and culverts can significantly increase upstream flooding.

- 7) *Loss of Fisheries Habitat.* The Yakima River supports populations of spring and fall Chinook salmon, Coho salmon, and summer steelhead trout; however, loss of channel complexity has diminished critical rearing and spawning habitat for salmonids.

Possible Future Concern

The USACE operates four dams within a 140-mile stretch of the Lower Snake River: Ice Harbor; Lower Monumental; Little Goose, and Lower Granite. These dams restrict salmon migration. One alternative suggested for improving salmon passage on the Lower Snake River is to breach the dams. Breaching the dams would remove their reservoir capacity and restore the affected portion of the river to a free-flowing condition. The municipalities of Benton County are concerned that breaching the dams could adversely affect the risk of flooding along the Columbia River and at the mouth of the Yakima River.

Ongoing Mitigation Efforts

Ongoing flood management and mitigation approaches used by the municipalities of Benton County typically follow FEMA requirements. New development in the floodway is generally not permitted. Existing development in the floodway can be replaced only within the same footprint, and it must be elevated above predictable flood levels. Development within the 100-year floodplain is allowed in the County, but is required to be raised above flood levels.

4.1.4 Flood Mitigation Strategy

Draft Comprehensive Flood Hazard Management Plan

Benton County prepared a draft Comprehensive Flood Hazard Management Plan (CFHMP) in March 2001; however the CFHMP was never adopted by the County. The primary goal of the draft CFHMP was to identify and evaluate flooding problems caused by the Yakima River and to develop cost-effective alternatives for the mitigation of these problems. The draft CFHMP provided a systematic and comprehensive process to identify areas and property susceptible to flood damages, prioritize problems based on severity, select alternatives to minimize identified flood hazard, and recommend solutions. The draft CFHMP, although never adopted and therefore not County policy, provides a detailed assessment of flood issues, including summations of prior studies, past flood history, areas of repetitive flood damages, identification of structures and infrastructure within the floodplain, and municipal regulatory tools for flood hazard management.

Potential flood hazard management alternatives identified in the draft CFHMP included construction projects, new policy decisions, land use modifications, enhancements to regulations, and options for retrofitting existing structures. The recommendations were then prioritized based on the number and priority of flooding issues each recommendation addressed, and on the following five criteria:

1. Relative cost
2. Time needed for implementation
3. Potential for success in solving the issue
4. Technical feasibility
5. Social/political feasibility

The recommendations developed in the draft CFHMP are provided as Attachment 7-A, in Section 1, Chapter 7 of this Plan.

Other Potential Mitigation Measures

The following are potential measures to mitigate the hazard posed by floods. The list is not definitive – there may be other potential mitigation actions. The potential mitigation measures listed below are not recommended action items for the municipalities of Benton County. Rather, they are included here as examples of the types of mitigation measures other cities and counties have used or considered for similar hazards. The potential mitigation measures have been categorized by the type of mitigation response they represent. Although there are many precautions that can be taken to limit the likelihood of floods, it is not feasible to hope to eliminate a naturally occurring hazard. Therefore, mitigation response must focus on limiting the exposure of people and property to the hazard, and limiting the vulnerability of property to the hazard. Types of mitigation response typically include:

Limiting Exposure

- Removing existing development within the area of hazard.
- Restricting future development within the area of hazard.

Limiting Vulnerability

- Providing structural defenses against the impacts of the hazard.
- Providing nonstructural defenses against the impacts of the hazard.
- Providing hazard mitigation education to affected communities and the general public.
- Ensuring that plans, procedures, facilities, equipment, and trained personnel are available to provide for adequate hazard response and recovery.

Removing existing development within the area of hazard

1. Developing an acquisition or “buyout” program to purchase property subject to repetitive flooding. The buyout program would consist of the City/County purchasing subject properties using a combination of municipal funds and grant money; removing structures, etc. subject to damage from floods, and restoring the site to provide a natural buffer and to preserve open space.
2. Removing and relocating critical facilities or system components outside the floodplain.

Restricting Future Development Within the Area of Hazard

3. Restricting development within the floodplain through available land use planning and zoning requirements.
4. Revising requirements for development within the floodplain, where appropriate. Ideas for implementation include:
 - Evaluate elevation requirements for new residential and nonresidential structures in the unincorporated floodplain area;
 - Explore raising the base elevation requirement for new residential construction to two or three feet above base flood elevation, or greater. An increased elevation standard is one

- activity the County can engage in to receive credit from the NFIP Community Rating System Program;
- Identify opportunities to upgrade applicable Federal Insurance Rate Maps, and arrange for Cooperative Technical Partnership mapping upgrades for select areas; and
 - Identify other alternatives to reduce development in the floodplain.
5. Developing acquisition and management strategies to preserve open space for flood mitigation, fish habitat, and water quality in the floodplain. Ideas for implementation include:
- Developing a comprehensive strategy for acquiring and managing floodplain open space;
 - Exploring funding for property acquisition from federal (e.g., FEMA Hazard Mitigation Grant Program), state, regional, and local governments, as well as private and non-profit organizations, trails programs, fish programs as well as options for special appropriations;
 - Developing a regional partnership between flood mitigation, fish habitat, and water quality enhancement organizations/programs to improve educational programs;
 - Identifying sites where environmental restoration work can benefit flood mitigation, fish habitat, and water quality;
 - Working with landowners to develop flood management practices that provide healthy fish habitat; and
 - Identifying existing watershed education programs and determining which programs would support a flood education component.

Providing Structural Defenses Against the Impacts of the Hazard

6. Improve drainage in proximity to the facility or system component.
7. Construct flood walls, dikes, etc. to prevent contact with water/floating debris.
8. Elevate the structure or system component above predicted floodwater height.
9. Elevate vulnerable components (e.g., electronics) above predicted flood height.
10. Prevent the entry of floodwater or damage from water immersion.
11. Provide waterproof doors and seals for wall openings and/or seal components.
12. Replace vulnerable components with waterproof components.
13. Install back-flow prevention valves in sewers and drains.
14. Purchase and install seals for drains.
15. Improve seals on all wall penetrations below floodwater levels.
16. Relocate vulnerable interior contents, furniture, etc. to higher levels in structure.

17. Prevent floatation and/or movement of the structure or component. Ideas for implementation include:
 - Strengthen fastening of structure sill to foundation
 - Strengthen/reinforce foundation against movement
 - Anchor facility components against physical force of flood water
18. Remove or anchor all outbuildings, decks, etc.
19. Elevate/secure all exterior features, e.g., propane tanks, electronics, etc.

Providing Nonstructural Defenses Against the Impacts of the Hazard

20. Insure the structure and/or its contents under the National Flood Insurance Program
21. Enhance the standing of the jurisdiction in the NFIP Community Rating System to lower flood insurance premiums.
22. Determine/confirm the elevation of the structure, component, and/or flood height.
23. Conduct an engineering evaluation of structure or component vulnerability to flooding.
24. Develop a plan/procedure for flood damage control .
25. Provide temporary protection of the facility or component (sand bagging, etc.).
26. Provide temporary relocation and storage of equipment, contents and furniture.

Providing Hazard Mitigation Education to Affected Communities, Businesses and the General Public

27. Develop procedures for temporary relocation of furniture, contents, etc. to higher levels.
28. Inform community of flood risk for facility or component.
29. Train affected public in flood plans/procedures for facility component protection.
30. Promote actions for flood protection of homes and property.
31. Develop a post-flood cleanup, decontamination, and recovery plan/procedure.
32. Educate community on structure/component vulnerability and actions taken.
33. Prepare, train, and practice community/facility evacuation plans.

Ensuring that Plans, Procedures, Facilities, Equipment, and Trained Personnel are Available to Provide for Adequate Hazard Response and Recovery

34. Develop better flood warning systems. Ideas for implementation include:

- Coordinate with appropriate organizations to evaluate the need for more stream gauges; and
- Distribute information regarding flooding to the general public efficiently.

35. Enhance data and mapping for floodplain information, and identify and map flood-prone areas outside of designated floodplains. Ideas for implementation include:

- Apply for FEMA's cooperative technical partnership using 2-foot contour interval floodplain mapping data.
- Encourage the development of floodplain maps for all local streams not currently mapped on Flood Insurance Rate Maps or County/City maps, with special attention focused on mapping rural and unincorporated areas. The maps should show the expected frequency of flooding, the level of flooding, and the areas subject to inundation. The maps can be used for planning, risk analysis, and emergency management.

36. Identify surface water drainage obstructions. Ideas for implementation include:

- Map culverts in unincorporated areas;
- Prepare an inventory of culverts that historically create flooding problems and target them for retrofitting; and
- Prepare an inventory of major urban drainage problems, and identify causes and potential mitigation actions for urban drainage problem areas.

4.1.5 Flood Resource Directory

The following resource directory lists the resources and programs that can assist County communities and organizations. The resource directory will provide contact information for local, regional, state and federal programs that deal with natural hazards.

Federal Resources

Federal Emergency Management Agency (FEMA)

FEMA provides maps of flood hazard areas, various publications related to flood mitigation, funding for flood mitigation projects, and technical assistance. FEMA also operates the National Flood Insurance Program. FEMA's mission is to reduce loss of life and property and protect the nation's critical infrastructure from all types of hazards through a comprehensive, risk-based, emergency management program of mitigation, preparedness, response and recovery. FEMA Region X serves the northwestern states of Alaska, Idaho, Oregon and Washington

Contact: FEMA, Federal Regional Center, Region 10

Address: 228th St. SW, Bothell, WA 98021-9796

Phone: (425) 487-4678

Website: <http://www.fema.gov>

To obtain FEMA publications:

Phone: (800) 480-2520

To obtain FEMA maps:

Contact: Map Service Center

Address: P.O. Box 1038, Jessup, Maryland 20794-1038

Phone: (800) 358-9616

Fax: (800) 358-9620

National Flood Insurance Program (NFIP)

Washington has 256 flood-prone communities. Flood insurance is available to citizens in communities that adopt and implement NFIP building standards. The standards are applied to development that occurs within a delineated floodplain, a drainage hazard area, and properties within 250 feet of a floodplain boundary. These areas are depicted on federal Flood Insurance Rate Maps.

Contact: National Flood Insurance Program

Website: <http://www.fema.gov/fima/nfip.shtm>

The Community Rating System (CRS)

The Community Rating System (CRS) recognizes community floodplain management efforts that go beyond the minimum requirements of the NFIP. Property owners within the City would receive reduced NFIP flood insurance premiums if the City implements floodplain management practices that qualify it for a CRS rating.

Contact: National Flood Insurance Program

Website: <http://www.fema.gov/fima/nfip.shtm>

The Floodplain Management Association

The Floodplain Management website was established by the Floodplain Management Association (FMA) to serve the entire floodplain management community. It includes full-text articles, a calendar of upcoming events, a list of positions available, an index of publications available free or at nominal cost, a list of associations, a list of firms and consultants in floodplain management, an index of newsletters dealing with flood issues (with hypertext links if available), a section on the basics of floodplain management, a list of frequently asked questions (FAQs) about the Website, and a catalog of Web links.

Contact: Floodplain Management Association

Website: <http://www.floodplain.org>

Email: admin@floodplain.org

The Association of State Floodplain Managers

The Association of State Floodplain Managers is an organization of professionals involved in floodplain management, flood hazard mitigation, the National Flood Insurance Program, and flood preparedness, warning, and recovery. ASFPM fosters communication among those responsible for flood hazard activities, provides technical advice to governments and other entities about proposed actions or policies that will affect flood hazards, and encourages flood hazard research, education, and training. The ASFPM Web site includes information on how to become a member, the organization's constitution and bylaws, directories of officers and committees, a publications list, information on upcoming conferences, a history of the association, and other useful information and Internet links.

Contact: The Association of State Floodplain Managers
Address: 2809 Fish Hatchery Road, Madison, WI 53713
Phone: (608) 274-0123
Website: <http://www.floods.org>

Northwest Regional Floodplain Managers Association (NORFMA)

This site is a resource for floodplains, fisheries, and river engineering information for the Northwest. This site provides technical information, articles, and Internet links in the field of floodplain and fisheries management.

Contact: Northwest Regional Floodplain Managers Association
Website: <http://www.norfma.org/>

FEMA's List of Flood Related Information

This site contains a long list of FEMA brochures, documents, and flood related information sites, and is a good resource point for FEMA flood information on the Internet.

Contact: Federal Emergency Management Agency.
Phone: (800) 480-2520
Website: <http://www.fema.gov/library/prepandprev.shtm>

National Weather Service, Pendleton Weather Forecast Office

The National Weather Service provides flood watches, warnings, and informational statements for rivers in Benton County. The NWS Pendleton office provides river level information online and by phone.

Contact: National Weather Service, Pendleton Weather Forecast Office
Address: 2001 NW 50th Drive, Pendleton, OR 97801
Phone: (541) 276-7832
Website: <http://www.wrh.noaa.gov>

Office of Hydrology, National Weather Service

The National Weather Service's Office of Hydrology (OH) and its Hydrological Information Center offer information on floods and other aquatic disasters. This site offers current and historical data including an archive of past flood summaries, information on current hydrologic conditions, water supply outlooks, an Automated Local Flood Warning Systems Handbook, Natural Disaster Survey Reports, and other scientific publications on hydrology and flooding.

Contact: Office of Hydrology, National Weather Service
Website: <http://www.nws.noaa.gov/oh/hic/>

National Resources Conservation Service (NRCS), US Department of Agriculture

NRCS provides a suite of federal programs designed to assist state and local governments and landowners in mitigating the impacts of flood events. The Watershed Surveys and Planning Program and the Small Watershed Program provide technical and financial assistance to help participants solve natural resource and related economic problems on a watershed basis. The Wetlands Reserve Program and the Flood Risk Reduction Program provide financial incentives to landowners to put aside land that is either a wetland resource, or that experiences frequent flooding. The Emergency Watershed Protection Program (EWP) provides technical and financial assistance to clear debris from clogged waterways, restore vegetation, and stabilizing riverbanks.

The measures taken under EWP must be environmentally and economically sound and generally benefit more than one property

Contact: Resource Conservationist, Prosser Service Center

Address: 618 8th Street, Prosser, WA, 99350-1444

Phone: (509) 786-1923

Website: <http://www.nrcs.usda.gov/>

United States Geological Survey (USGS)

The USGS website provides current streamflow conditions at USGS gauging stations in Washington and throughout the Pacific Northwest. The Washington USGS office is responsible for water-resources investigations for Washington. Their office cooperates with local, state, and federal agencies in Washington. Cooperative activities include water-resources data collection and interpretive water-availability and water-quality studies. Information on Washington State and the USGS offices in Washington is available through the USGS website.

Contact: USGS Washington District Office

Address: 1201 Pacific Avenue, Suite 600, Tacoma, WA 98402

Phone: (253) 428-3600

Website: <http://www.usgs.gov/>

Bureau of Reclamation

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Contact: Bureau of Reclamation, Pacific Northwest Region

Address: 1150 N. Curtis Road, Boise, ID 83706

Phone: (208) 378-5012

Website: <http://www.usbr.gov/pn/>

Army Corps of Engineers

The Corps of Engineers administers a permit program to ensure that the nation's waterways are used in the public interest. Any person, firm, or agency planning to work in waters of the United States must first obtain a permit from the Army Corps of Engineers. The Corps is responsible for the protection and development of the nation's water resources, including navigation, flood control, energy production through hydropower management, water supply storage and recreation. Benton County is served by two Corps Districts: the Columbia River is within the Walla Walla District; and the Yakima River is within the Seattle District.

Contact: US Army Corps of Engineers-Walla Walla District

Address: 201 North 3rd Avenue, Walla Walla, WA 99362

Phone: (509) 527-7020

Website: <http://www.nwp.usace.army.mil/>

Contact: US Army Corps of Engineers-Seattle District

Address: PO Box 3755, Seattle, WA 98124-3755

Phone: (206) 764-3406

Website: <http://www.nwp.usace.army.mil/>

Publications

NFIP Community Rating System Coordinator's Manual. FEMA/NFIP. Indianapolis, IN. This informative brochure explains how the Community Rating System works and what the benefits are to communities. It explains in detail the CRS point system, and what activities communities can pursue to earn points. These points then add up to the “rating” for the community, and flood insurance premium discounts are calculated based upon that “rating.” The brochure also provides a table on the percent discount realized for each rating (1-10). Instructions on how to apply to be a CRS community are also included.

Contact: NFIP Community Rating System
Phone: (800) 480-2520 or (317) 848-2898
Website: <http://www.fema.gov/nfip/crs.shtm>

Floodplain Management: This FEMA website presents an overview of FEMA floodplain management programs. Floodplain management is the operation of a community program of corrective and preventative measures for reducing flood damage. These measures take a variety of forms and generally include zoning, subdivision, or building requirements, and special-purpose floodplain ordinances. This website discusses floodplain processes and terminology. It contains floodplain management and mitigation strategies, as well as information on the NFIP, CRS, Community Assistance Visits, and floodplain development standards.

Contact: FEMA Mitigation Division
Phone: (800) 480-2520
Website: <http://www.fema.gov/fima/floodplain.shtm>

Flood Hazard Mitigation Planning: A Community Guide, (June 1997), Massachusetts Department of Environmental Management. This informative guide offers a 10-step process for successful flood hazard mitigation. Steps include: map hazards, determine potential damage areas, take an inventory of facilities in the flood zone, determine what is or is not being done about flooding, identify gaps in protection, brainstorm alternatives and actions, determine feasible actions, coordinate with others, prioritize actions, develop strategies for implementation, and adopt and monitor the plan.

Contact: Massachusetts Flood Hazard Management Program
Phone: (617) 626-1250
Website: <http://www.magnet.state.ma.us/dem/programs/mitigate>

Reducing Losses in High Risk Flood Hazard Areas: A Guidebook for Local Officials, (February 1987), FEMA-116. This guidebook offers a table on actions that communities can take to reduce flood losses. It also offers a table with sources for floodplain mapping assistance for the various types of flooding hazards. There is information on various types of flood hazards with regard to existing mitigation efforts and options for action (policy and programs, mapping, regulatory, non-regulatory). Types of flooding which are covered include alluvial fan, areas behind levees, areas below unsafe dams, coastal flooding, flash floods, fluctuating lake level floods, ground failure triggered by earthquakes, ice jam flooding, and mudslides.

Contact: Federal Emergency Management Agency
Phone: (800) 480-2520
Website: <http://www.fema.gov>

Benton County Comprehensive Flood Hazard Management Plan, Draft, (March 2001). This is a study of Benton County's historical floods, flood characteristics, areas prone to flooding, management options, current hazards and potential solutions.

Contact: Benton County Planning/Building Department

Phone: (509) 786-5612

Website: <http://www.co.benton.wa.us/>